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TAXONOMIC STATUS AND BIOLOGY OF THE CUBAN BLACK-HAWK, *BUTEOGALLUS ANTHRACINUS GUNDLACHII* (AVES: ACCIPITRIDAE)

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ABSTRACT.—We reevaluate the taxonomic status of the Cuban population of the Common Black-Hawk (*Buteogallus anthracinus*) based on our examination of additional specimens, nests, eggs, and voice data. *Buteogallus a. gundlachii* is smaller than mainland populations of *anthracinus* and differs from mainland birds in plumage coloration and pattern. The common (alarm) call of *gundlachii* is a series of three or four notes, differing from that of mainland *anthracinus*, whose call consists of 9–24 notes. In the Isla de Pinos, Cuba, we observed *gundlachii* eating two species of land crabs (71.4%), centipedes (7.1%), lizards (10.7%), mammals (7.1%), and a bird (3.6%). We consider *Buteogallus gundlachii* Cabanis 1854 (1855), the Cuban Black-Hawk, to be a full species, endemic to Cuba, Isla de Pinos, and many of the cays of the Cuban Archipelago.

KEY WORDS: *Common Black-Hawk*; *Buteogallus anthracinus*; *Cuban Black-Hawk*; *Buteogallus gundlachii*; *Buteogallus subtilis*; *ecology*; *taxonomy*.

ESTADO TAXONÓMICO Y BIOLOGÍA DE *BUTEOGALLUS ANTHRACINUS GUNDLACHII* (AVES: ACCIPITRIDAE)

RESUMEN.—En este estudio re-evaluamos el estatus taxonómico de la población cubana de *Buteogallus anthracinus* (subespecie *gundlachii*) con base en exámenes de especímenes adicionales, nidos, huevos y datos de la voz. Los individuos de *B. a. gundlachii* son más pequeños que los individuos de las poblaciones continentales de *B. anthracinus*, y difieren de las aves del continente en la coloración y patrón del plumaje. El llamado común de alarma de *gundlachii* es una serie de tres o cuatro notas, mientras que el llamado de *anthracinus* en el continente consiste de entre 9 y 24 notas. En la Isla de Pinos, Cuba, observamos a *gundlachii* alimentándose de dos especies de cangrejos terrestres (71.4%), ciempiés (7.1%), lagartijas (10.7%), mamíferos (7.1%) y un ave (3.6%). Consideramos *Buteogallus gundlachii* Cabanis, 1854 (1855) debe ser tratado como una especie distinta, endémica de Cuba, la Isla de Pinos y muchos de los cayos del archipiélago cubano.

[Traducción del autores]

The New World genus *Buteogallus* Lesson, 1830 includes five species, mostly restricted to tropical areas, including Great Black-Hawk (*Buteogallus uru-*

bitinga) of the lowlands of Mexico to northern Argentina, Savanna Hawk (*B. meridionalis*) inhabiting savannas and marshes of western Panama to northern Argentina, Rufous Crab-Hawk (*B. aequinoctialis*) occurring in mangroves of northeastern

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Venezuela to eastern Brazil (Paraná), and Mangrove Black-Hawk (*B. subtilis*), which is restricted to the Pacific coasts and rivers of El Salvador south to northwestern Peru. The Common Black-Hawk (*Buteogallus anthracinus*, Deppe 1830) ranges from southwestern United States, south to extreme northern South America (coastal Venezuela to northeastern Guiana), Colombia, to northern Peru, including Trinidad, and some of the West Indies (Bond 1950, American Ornithologists' Union 1998). One of the West Indian populations (*B. a. cancrivorus* Clark 1905b) is restricted to St. Vincent, St. Lucia, Union Island (Grenadines), and Grenada (accidental and doubtful in last two islands; no specimens taken; Clark 1905a, 1905b, 1905c, Bond 1950, Evans 1990) in the Lesser Antilles, whereas the only other Antillean population (*B. a. gundlachii* Cabanis 1854 [1855]) occurs in Cuba and its satellites. The taxonomic status of the Cuban population has been controversial, with some considering the form as a full species, *Buteogallus gundlachii* (as originally described by Cabanis [1854, actually 1855]) instead of *Buteogallus anthracinus gundlachii* (American Ornithologists' Union 1998). Among those authorities who have considered the Cuban form *gundlachii* conspecific with the continental species (*anthracinus*) are Sharpe (1874, 1899), Cory (1887, 1892), Bangs and Zappé (1905), Bond (1956a, 1956b), Amadon (1961), Brown and Amadon (1968), Mayr and Short (1970), Stresemann and Amadon in Mayr and Cottrell (1979), Palmer (1988), Sibley and Monroe (1990), Ferguson-Lees and Christie (2001), Dickinson (2003), and others. Conversely, other authors have considered *gundlachii* different from *Buteogallus anthracinus* at the species level: Cabanis (1855), Gundlach (1854, 1865–1866a, 1865–1866b, 1871, 1876), Ridgway (1876), Gurney (1876, 1934), Bangs (1905), Swann (1921–1922, 1930), Peters (1931), Bond (1936), Hellmayr and Conover (1949), Friedmann (1950), Monroe (1963, 1968), Wetmore (1965), and others. Some of these authors subsequently changed their opinions on the Cuban form's status, later considering *gundlachii* conspecific with *anthracinus* (e.g., Gundlach 1893, Bond 1950, 1956a, 1956b). With rare exception, however, previous evaluations did not consider the important characteristics of breeding biology and voice, mainly because of the limited knowledge of the Cuban form resulting from the difficulty in reaching its breeding habitats. The lack of natural history information is not unique to *gundlachii*, but

is also true for other forms of the genus *Buteogallus*, e.g., *anthracinus* and *subtilis*, which are currently recognized as different species (Aldrich and Bole 1937, Amadon 1982, Mayr and Cottrell 1979, Stiles and Skutch 1989, Sibley and Monroe 1990, American Ornithologists' Union 1998, Ridgely and Greenfield 2001), but with reservation by some authors (Stiles and Skutch 1989, American Ornithologists' Union 1998, Ridgely and Greenfield 2001).

Here, we reevaluate the taxonomic status of the Cuban population of *Buteogallus anthracinus gundlachii*, based on our examination of more specimens, nests, eggs, and behavioral data, especially vocalizations, than were considered by previous workers. All published work on the Cuban form has been based on information from the few specimens collected before 1960, all of which are deposited in foreign institutions. In this study, we include specimens in North American and Cuban collections, including those collected after 1960, and not evaluated previously.

Our main comparison in this assessment is with *anthracinus*, the taxon most often linked to *gundlachii*. In these comparisons, we refer to Cuban populations as *gundlachii* and other forms as *anthracinus*. It is not the purpose of this contribution to speculate on the taxonomic status of *Buteogallus subtilis* (including the three subspecies), although we make some comparisons between *subtilis* and *gundlachii*.

STUDY AREA

Many of the observations reported here were made during our 30 yr of field experience throughout Cuba. We made more intensive observations of nesting black-hawks from 1996 to 1998 at the Los Indios Ecological Reserve, Isla de Pinos (now Isla de la Juventud). Major vegetational communities at Los Indios include: (1) mangrove forest formation, characterized by black mangrove (*Avicennia germinans*) and red mangrove (*Rhizophora mangle*); (2) semi-deciduous gallery forests, with prominent Cuban royal palm (*Roystonea regia*), beach hibiscus (*Hibiscus tiliaceus*), and pond apple (*Annona glabra*); (3) the open forest (savanna) formation of an open pine (*Pinus caribaea* and *P. tropicalis*) and Cuban bottle palm (*Colpotherinax wrightii*), with silver saw palm (*Acoelorrhaphe wrightii*) and a sparse undergrowth; and (4) the pine-barren formation, with pines and palms, and an undergrowth predominantly of *Pachyanthus cubensis*, *P. poiretii*, *Kalmiella aggregata*, *Miconia delicatula*, *Polygala uncinata*, *Lyonia myrtilloides*, and *Pinguicula filifolia* (Jennings 1917, Alain 1946). Black-hawk observations were made mainly in the mangrove and gallery forests. Additional intensive observations in red and black mangrove habitats were made in Ciénaga de Zapata in December 1999. An elevated road bed, lined with *Casuarina equisetifolia* and scrub veg-

etation, bisects the mangrove forest where we made our observations near Playa Larga.

METHODS

We examined specimens of *Buteogallus a. anthracinus* ($N = 37$), *B. a. gundlachii* (12), *B. a. cancrivorus* (4), *B. subtilis* (25), *B. aequinoctialis* (3), and *B. urubitinga* (24) deposited in the Field Museum of Natural History (Chicago), Museum of Comparative Zoology (Harvard University), American Museum of Natural History, United States National Museum of Natural History, Academy of Natural Sciences of Philadelphia, Louisiana State University Museum of Natural History, Museo Nacional de Historia Natural de Cuba (La Habana), and Instituto de Ecología y Sistemática (Cuba) (Table 1). Conventional measurements of wing chord (flattened against the ruler), tail, tarsus, and exposed culmen were taken to the nearest 0.1 mm with calipers. Egg masses were measured to the nearest gram using spring scales. We present summary descriptive statistics (mean, SD, and range) for the specimens. We plotted body measurements to assess the pattern of spatial segregation among populations and forms. The hypothesis of separation derived from the plots of body measurements was tested using discriminant function analysis (DFA; Kleinbaum and Kupper 1978). SPSS (1999) for Windows was used to run DFA.

RESULTS

Morphometrics and Plumage. *Adult morphology.* Our examinations of the two taxa of *B. anthracinus* (*anthracinus* and *gundlachii*) revealed differences in size and coloration. We found sexual size dimorphism in three of the measurements taken of specimens of mainland *anthracinus* (Table 1). Therefore, size comparisons between *anthracinus* and *gundlachii* were made within sex; i.e., male *anthracinus* with male *gundlachii* and female *anthracinus* with female *gundlachii*. Tarsal length was not different in either population, so for comparing *anthracinus* with *gundlachii* tarsi we combined male and female measurements for that morphometric parameter. Only measurements of wing and exposed culmen for *gundlachii* revealed sexual size dimorphism ($P < 0.01$; Table 1), although the small sample size of females ($N = 5$) precluded a reliable analysis. Measurements of *gundlachii* yielded a mean Dimorphic Index (Storer 1966) of 6.9, compared with a mean index of 5.6 for *anthracinus* (Table 1).

Birds from Cuba (*gundlachii*) are substantially smaller than mainland (*anthracinus*) birds in some conventional measurements, including wing chord in both sexes and tail length in males (Table 2). Also, tarsal lengths (combined male and female measurements) were significantly different between the two forms ($P = 0.001$). A stepwise selec-

tion procedure within DFA revealed wing chord, tail length, and exposed culmen were the most important of the size variables measured. Plots contrasting these variables within sex showed *anthracinus* and *gundlachii* tended to occupy generally distinct regions of the morphological space (Fig. 1).

To further examine size differences between the two populations, we used linear discriminant analysis to classify specimens into two groups ("race"), mainland *anthracinus* and Cuban *gundlachii*, using lengths of wing chord, tail, culmen, and tarsus as predictors. For male *anthracinus*, the analysis produced a true group classification proportion of 0.938 (15 of 16 correctly classified) and 0.857 (6 of 7 correctly classified) for *gundlachii* males, for an overall proportion correct of 0.913 (21 of 23) (Wilks's lambda = 0.375; $\chi^2 = 17.646$; $df = 4$, $P < 0.001$). For females, the analysis produced a true group classification proportion of 0.857 (18 of 21) for *anthracinus* and 0.800 (4 of 5) for *gundlachii* individuals, for an overall proportion correct of 0.846 (22 of 26) (Wilks's lambda = 0.495; $\chi^2 = 14.781$; $df = 4$, $P < 0.005$).

The four adult female St. Vincent (*B. a. cancrivorus*) specimens we examined were somewhat larger in wing chord ($\bar{x} = 389 \pm 7.63$, range = 385–401; $t = -4.99$, $P = 0.002$, $df = 6$) than *gundlachii* females, whereas we found no difference between the two island forms in tail (213.3 ± 12.4 ; range = 200–230; $t = -1.83$, $P > 0.05$, $df = 6$), culmen (27.3 ± 0.8 ; range = 26.8–28.4; $t = 0.60$, $P > 0.05$, $df = 5$), or tarsus (85.5 ± 6.4 ; range = 81.0–94.9; $t = -1.63$, $P > 0.05$, $df = 4$) length. We found no differences ($P > 0.05$) in measurements between *anthracinus* and *cancrivorus*.

In general coloration, *gundlachii* differs from *B. anthracinus* and *B. subtilis* in being chocolate-brown, not slate blackish or even black as in the latter two forms. However, some specimens of *anthracinus*, especially of the race *cancrivorus*, have a tendency to be less blackish, almost dark brown.

The underparts feathers of *gundlachii* have a light (brownish-gray) edge, more conspicuous toward the abdominal region and more broadly edged on the alula coverts than in *anthracinus*, with the edging on the terminal alula coverts becoming white bands. The margins of the flank and thigh feathers are heavily marked, forming a series of bands, although these bands tend to disappear in older birds. The shoulder feathers are boldly barred in white, contrasting with the chocolate-

Table 1. Sexual size dimorphism in four body measurements from specimens of *Buteogallus anthracinus* (mainland *Buteogallus a. anthracinus* and Cuban *B. a. gundlachii*), *B. subtilis*, *B. aequinoctialis*, and *B. urubitinga*, expressed as mean, standard deviation, range, and sample size (in parentheses). Statistical analyses are between-sex comparisons (two-sample *t*-test; equal variances not assumed).

| SPECIES STRUCTURE | SEX | | <i>t</i> | df | <i>P</i> | SIGNIF- ICANCE ^a | D.I. ^b |
|-----------------------------------|--------------------------------|---------------------------------|----------|----|----------|--------------------------------|-------------------|
| | MALE | FEMALE | | | | | |
| <i>Buteogallus anthracinus</i> | | | | | | | |
| Wing | 371.69 ± 11.95 (16) 341–393 | 385.19 ± 11.21 (21) 360–421 | −3.50 | 31 | 0.001 | * | 3.6 |
| Tail | 195.50 ± 7.40 (16) 183–210 | 213.81 ± 10.61 (21) 190–230 | −6.18 | 34 | 0.0001 | * | 8.9 |
| Exposed culmen | 26.27 ± 0.82 (16) 25.1–28.1 | 27.40 ± 1.25 (20) 23.6–30.3 | 3.24 | 32 | 0.003 | * | 4.2 |
| Tarsus | 85.94 ± 2.65 (16) 80–90.0 | 85.42 ± 4.00 (21) 80.3–92.7 | 0.48 | 34 | 0.636 | ns | −0.6 |
| Mean D.I. | | | | | | | 4.0 |
| <i>Buteogallus gundlachii</i> | | | | | | | |
| Wing | 342.71 ± 12.16 (7) 323–370 | 363.00 ± 8.43 (5) 350–372 | −3.41 | 9 | 0.008 | * | 5.8 |
| Tail | 179.29 ± 9.12 (7) 167–197 | 191.60 ± 22.16 (5) 182–233 | −1.15 | 4 | 0.313 | ns | 6.6 |
| Exposed culmen | 25.32 ± 0.69 (7) 24.5–28.5 | 27.54 ± 0.61 (5) 26.7–28.1 | −5.84 | 9 | 0.0001 | * | 8.3 |
| Tarsus | 81.33 ± 3.57 (6) 75.4–87 | 79.67 ± 3.56 (5) 79.0–87.7 | 0.77 | 8 | 0.464 | ns | −2.1 |
| Mean D.I. | | | | | | | 4.7 |
| <i>Buteogallus subtilis</i> | | | | | | | |
| Wing | 348.0 ± 13.68 (12) 330–370 | 352.31 ± 13.43 (13) 328–373 | −0.79 | 22 | 0.436 | ns | 1.2 |
| Tail | 189.92 ± 14.58 (12) 168–220 | 191.69 ± 8.65 (13) 180–205 | −0.37 | 17 | 0.719 | ns | 0.9 |
| Exposed culmen | 25.46 ± 2.06 (12) 19.7–27.8 | 26.56 ± 1.56 (12) 23.1–28.8 | −1.47 | 20 | 0.157 | ns | 4.2 |
| Tarsus | 79.78 ± 3.09 (11) 73.3–84.1 | 79.55 ± 2.76 (13) 75.0–84.0 | 0.19 | 19 | 0.848 | ns | −0.3 |
| Mean D.I. | | | | | | | 1.5 |
| <i>Buteogallus aequinoctialis</i> | | | | | | | |
| Wing | 315.5 ± 0.71 (2) 315–316 | 322 (1) | | | | | |
| Tail | 155.0 ± 2.83 (2) 153–157 | 155 (1) | | | | | |
| Exposed culmen | 23.55 ± 0.92 (2) 22.9–24.2 | 16.8 (1) | | | | | |
| Tarsus | 74.5 ± 3.54 (2) 72–77 | 72.8 (1) | | | | | |
| <i>Buteogallus urubitinga</i> | | | | | | | |
| Wing | 384.94 ± 16.68 (16) 362–412 | 389.63 ± 18.36 (8) 365–415 | −0.61 | 12 | 0.555 | ns | 0.1 |
| Tail | 225.13 ± 13.50 (16) 190–250 | 234.63 ± 17.54 (8) 210–260 | −1.35 | 11 | 0.206 | ns | 4.1 |
| Exposed culmen | 29.72 ± 1.05 (16) 26.7–30.9 | 30.78 ± 2.20 (8) 27.2–34.2 | −1.84 | 8 | 0.103 | ns | 3.5 |
| Tarsus | 112 ± 8.25 (16) 85.9–118.9 | 113.16 ± 7.76 (8) 98.8–123.0 | −0.11 | 14 | 0.910 | ns | 1.0 |
| Mean D.I. | | | | | | | 2.2 |

^a Significance, * = *P* < 0.05, ns = not significant.

^b D.I. = Dimorphic Index (Storer 1966).

Table 2. Mean, standard deviation, and sample size (parentheses) for wing chord, tail, culmen, and tarsus length for mainland (*Buteogallus a. anthracinus*) and Cuban (*Buteogallus a. gundlachii*) populations of the Common Black-Hawk. Statistical analyses are within-sex comparisons (two-sample *t*-test; equal variances not assumed) between mainland and Cuban specimens, except for tarsus, for which we found no sexual size dimorphism.

| STRUCTURE | SEX | TAXON | | <i>t</i> | df | <i>P</i> | SIGNIFICANCE ^a |
|----------------|----------------------|--------------------------|-------------------------|----------|----|----------|---------------------------|
| | | <i>B. A. ANTHRACINUS</i> | <i>B. A. GUNDLACHII</i> | | | | |
| Wing | M | 371.69 ± 11.95 (16) | 342.71 ± 12.16 (7) | 5.28 | 11 | <0.001 | * |
| | F | 385.19 ± 11.21 (21) | 363.00 ± 8.43 (5) | 4.94 | 7 | 0.002 | * |
| Tail | M | 195.50 ± 7.40 (16) | 179.29 ± 9.12 (7) | 4.14 | 9 | 0.003 | * |
| | F | 213.81 ± 10.61 (21) | 191.60 ± 22.16 (5) | 2.14 | 4 | 0.099 | ns |
| Exposed culmen | M | 26.27 ± 0.82 (16) | 25.32 ± 0.69 (7) | 2.86 | 13 | 0.013 | * |
| | F | 27.40 ± 1.25 (20) | 27.54 ± 0.61 (5) | -0.36 | 13 | 0.728 | ns |
| Tarsus | M and F ^b | 85.64 ± 3.45 (37) | 80.57 ± 3.49 (11) | 4.24 | 16 | 0.001 | * |

^a Significance, * = $P < 0.05$, ns = not significant.

^b Male and female tarsus data combined because specimens did not display sexual size dimorphism.

brown ground color. Remiges are dark brown, with wing coverts edged in grayish-cinnamon, especially the secondaries. The undersides of primaries and some secondaries have an extensive white patch, which constitutes the most distinctive character of the Cuban form. In *subtilis*, and especially *anthracinus*, this patch is mottled with grayish-brown. The tertiaries of *gundlachii* are heavily mottled grayish. This mottling is similar to the coloration of the primaries and secondaries of *anthracinus*, which has only an inconspicuous whitish patch on the undersides of these feathers. On the other hand, some specimens of *subtilis* display more white in this region than does *anthracinus*, but do not approach the amount shown in *gundlachii*.

The upperparts in *gundlachii* are also brown, with brownish-gray or with a trace of cinnamon on the feather margins. The head and pileum are uniformly chocolate brown. The rectrices are darker brown, almost blackish, with a broad white band of variable width (averaging 40 mm) in the middle of the tail. The tip of the tail is edged in white (as wide as 13 mm), which is a purer white than in *anthracinus* and *subtilis*. The feet and cere are yellow, the claws are black, and the iris is dark brown. The bill is blackish at the tip, becoming more yellowish toward the base on maxilla and mandible.

Immature morphology. Immature *gundlachii* individuals are not chocolate brown ventrally, but rather whitish, and heavily mottled with brown, having some feathers with considerable beige suffusion. Many feathers are mottled with medallion-like marks, whereas others are marked with elongated blotches, and some with streak-like dashes; these

marks are seldom present in fully-feathered immature birds. The sides of the face and throat are whitish, speckled with brown. The pileum, nape, and neck are heavily mottled or spotted with brown on a light (white or beige) background. Flanks and thighs also display considerable variation, with younger birds showing a lighter (whitish to brownish-beige) background, whereas older birds display more mottling or barring. The thighs are distinctly barred with light and dark bands in *subtilis* and *anthracinus*, whereas *gundlachii* has mottled or very lightly barred thighs.

The white patch of the underside of primaries is even more expanded and conspicuous in subadult than in adult *gundlachii*. Also, the subadult's tail is distinct from that of the adult's tail. When still not in full adult plumage, the subadult's tail shows remnants of several (as many as nine) thin, brownish bands, instead of displaying a single broad white band in the middle of the tail as in the adult. Some bands are complete, whereas others are somewhat broken. In Cuban birds, these bands are straight and parallel, whereas in the other forms they are oblique (chevron-like), as well as being much wider than in *gundlachii*. The bands become less delimited toward the tip; compared with the adult, the white tip of the subadult's tail is less demarcated, more grayish than white, and becomes browner from the tip toward the base.

Natural History. *Habitat.* Although we occasionally observed black-hawks within the white sand palm savanna of Los Indios, Isla de Pinos, nearly all observations were made in the coastal zone, primarily in mangrove forests or at the edges of that

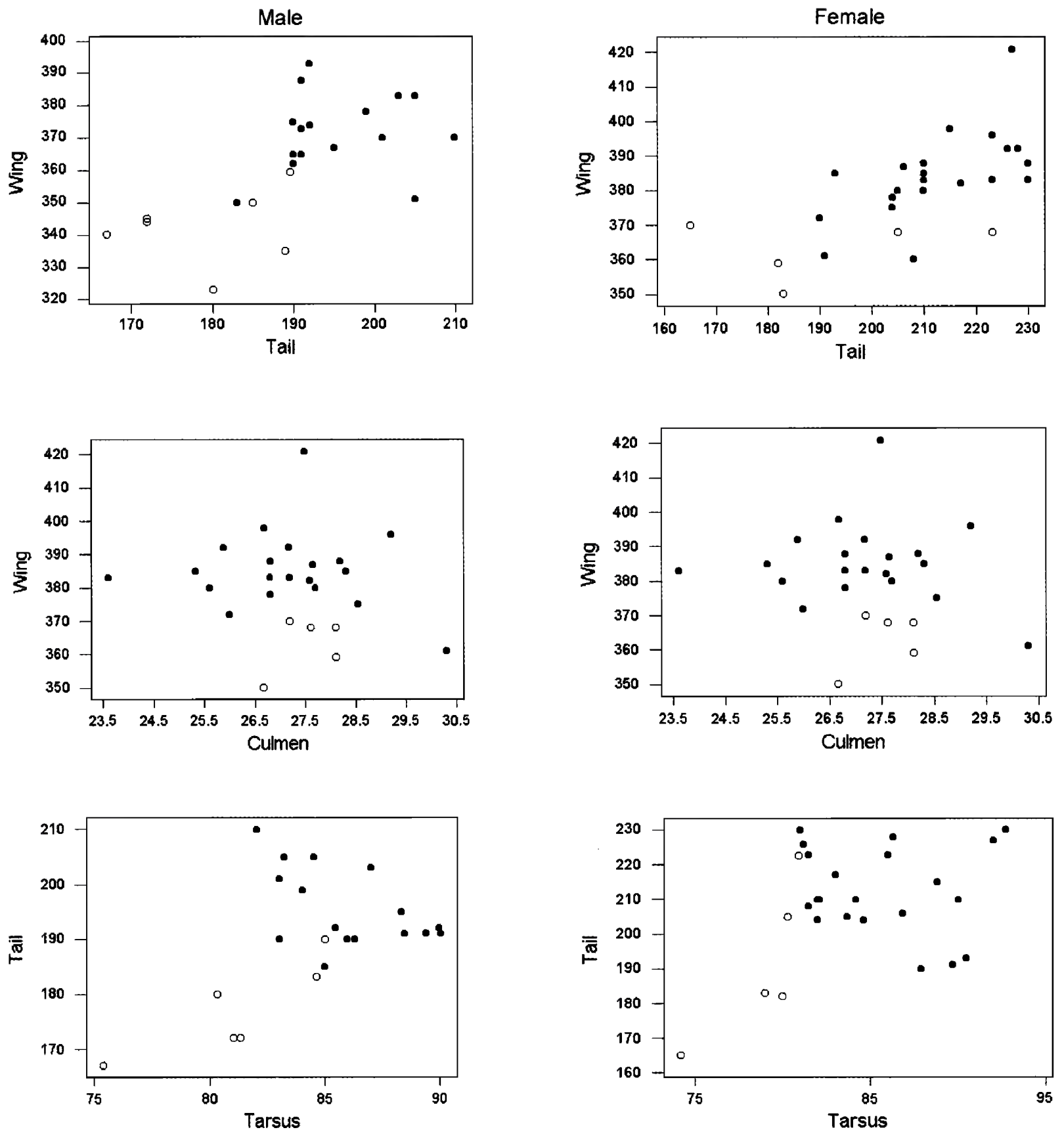


Figure 1. Plots contrasting body measurements of specimens of mainland *Buteogallus anthracinus anthracinus* (solid dots; $N = 16$ males, 21 females) and Cuban *B. a. gundlachii* (open circles; $N = 7$ males, 5 females).

habitat. Hawks hunted in the sparsely-vegetated mangrove pannes and flooded openings, where they foraged by perching in young or dead mangroves. We also saw black-hawks foraging or roosting in beach and coastal habitats, frequently perching in windbreaks of *Casuarina equisetifolia* at the edge of mangroves and dirt roads.

Nidification. We examined eight nests at Los Indios within the period of 14–27 May 1996–98. All

contained eggs, except the nest examined on 27 May 1996, which had one chick. During our observations at Isla de Pinos, which were well into the breeding season, we observed no aerial courtship, although individual *gundlachii* regularly soared silently for short periods above their nesting areas.

Of the eight *gundlachii* nests we examined at Los Indios, half were placed in black-mangroves and half in red-mangroves (Table 3). Each of the nests

Table 3. Nest and contents data for eight *Buteogallus anthracinus gundlachii* nests at Los Indios, Pinos, Cuba, 1996–98.

| COMPONENT | YEAR | | | | | | | | |
|--------------------------------|------------------|-------------------|-------------------|------------------|------------------|------------------|------------------|-------------------|-------------------|
| | 1996 | | | 1997 | | | 1998 | | |
| | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| Nest tree species ^a | <i>Avicennia</i> | <i>Rhizophora</i> | <i>Rhizophora</i> | <i>Avicennia</i> | <i>Avicennia</i> | <i>Avicennia</i> | <i>Avicennia</i> | <i>Rhizophora</i> | <i>Rhizophora</i> |
| Nest height (m) | 4 | 3.5 | 4 | 5 | 4.5 | 4 | 4 | 6 | 8 |
| Nest diameter (cm) | 70 | 98 | 93 | 99 | 80 | 105 | 105 | 107 | 85 |
| Nest depth (cm) | 45 | 88 | 89 | 91 | 75 | 95 | 95 | 94 | 72 |
| Nest bowl depth (cm) | 10 | 15 | 14 | 15 | 12 | 10 | 10 | 14 | 10 |
| Contents ^b | 1 E | 2 E | 1 C | 2 E | 1 E | 2 E | 2 E | 2 E | 1 E |
| Egg size (mm) No. 1 | 56.3 × 42.4 | 55.6 × 42.1 | | 56.1 × 43.6 | 55.8 × 43.1 | 56.9 × 43.2 | 56.9 × 43.2 | 55.1 × 42.3 | 55.7 × 42.3 |
| No. 2 | | 55.3 × 41.9 | | 54.7 × 42.9 | 56.4 × 42.9 | 56.3 × 42.2 | 56.3 × 42.2 | | |
| Egg mass (g) No. 1 | 61 | 59 | | 63 | 59 | 62 | 62 | 60 | 61 |
| No. 2 | | 60 | | 59 | | 63 | 63 | 64 | |

^a *Avicennia* = *Avicennia germinans*, *Rhizophora* = *Rhizophora mangle*.

^b E = egg, C = chick.

was in the subcanopy, shaded by foliage and was constructed completely of *Avicennia* and *Rhizophora* twigs. The nests showed a large range of sizes, probably the result of additions made in successive years. Two of the nests we monitored from 1996 through 1998 were reused by black-hawks, and increased in size with the addition of more nest materials in subsequent years. All nests examined at Los Indios contained fresh or older lining materials, consisting of green leaves and sprigs of *Avicennia* and *Rhizophora*, and some debris. Both adults were observed bringing green lining material to nests.

Nests had notably deep bowls (Table 3) and when adults were on nests incubating or brooding, they remained low in the bowl and were difficult to detect. During our inspections of nests at Los Indios, adults at three nests regularly perched placidly within 2 m of us while we measured eggs and chicks. Adults at a fourth nest were somewhat more aggressive, but the pair only flew low above our heads, occasionally calling, and vocalized from a nearby perch while we measured eggs.

We measured 11 eggs at Los Indios (Table 3). Three eggs collected by O. H. Garrido in Cayo Cantiles (Archipiélago de los Canarreos; deposited at Instituto de Ecología y Sistemática) measured 55.16×44.1 mm, 55.8×42.6 mm, and 57.08×42.34 mm. The 14 *gundlachii* eggs we measured averaged 55.87 ± 0.69 (range = 54.7 – 57.08) \times 42.71 ± 0.62 (range = 41.9 – 44.1) mm. Eggs of *gundlachii* are typically short sub-elliptical to elliptical, with a finely granulated texture. Eggs have a dull grayish-white ground color, sometimes with a greenish or bluish cast early in incubation, and are marked with spots and blotches of dark or reddish-brown, particularly at the larger end. Clutch sizes at Los Indios averaged 1.57 ± 0.53 ($N = 8$; range = 1–2) eggs (Table 3). The egg of *gundlachii* is usually more colored (bluish to greenish suffusion) than those of *anthracinus* or *subtilis*, which are typically grayish or whitish (Bent 1937, Wetmore 1965, O. Garrido pers. obs.).

Diet and foraging behavior. Cuban birds were found to feed on a variety of prey (Table 4). Notable was the lack of fish prey, although fishes were available in tidal channels in the study area. However, twice, hawks were observed wading in shallow tidal channels and making foot thrusts at probable fish prey. During our observation periods (May–June) at Los Indios, land crab populations were particularly high, and crabs were active and con-

Table 4. Prey of *Buteogallus anthracinus gundlachii* at Los Indios, Isla de Pinos, Cuba, 1996–1998, and Ciénaga de Zapata, Cuba, 1999–2000.

| PREY | NUMBER (%) | | | |
|------------------------------|--------------------------|--------------|-------------------|----------------------------|
| | OBSERVED BROUGHT TO NEST | PREY REMAINS | OBSERVED CAPTURES | TOTAL (%) ALL OBSERVATIONS |
| Invertebrates | | | | |
| Crab | | | | |
| <i>Cardisoma guanhumi</i> | 4 | 12 | 2 | 18 (64.3) |
| <i>Ucides cordatus</i> | 1 | 1 | | 2 (7.1) |
| Centipede sp. | 1 | 1 | | 2 (7.1) |
| Totals (invertebrates) | 6 (21.4) | 14 (50.0) | 2 (7.1) | 22 (78.6) |
| Vertebrates | | | | |
| Reptiles | | | | |
| Lizards | | | | |
| <i>Anolis</i> spp. | 1 | 1 | | 2 (7.1) |
| <i>Ameiva auberi</i> | 1 | | | 1 (3.6) |
| Totals (reptiles) | 2 (7.1) | 1 (3.6) | | 3 (10.7) |
| Birds | | | | |
| <i>Sora Porzana carolina</i> | | 1 | | 1 (3.6) |
| Totals (birds) | | 1 (3.6) | | 1 (3.6) |
| Mammals | | | | |
| <i>Rattus rattus</i> | | 2 | | 2 (7.1) |
| Totals (mammals) | | 2 (11) | | 2 (7.1) |
| Total (vertebrates) | 2 (7.1) | 4 (14.3) | | 6 (21.4) |
| Total (all observations) | 8 (28.6) | 18 (64.3) | 2 (7.1) | 28 |

spicuous in the early mornings and evenings, when most of our observations of prey delivery and captures were made. In December 1999, we also observed *gundlachii* capturing several crabs (*Cardisoma guanhumi*) along the coast of Ciénaga de Zapata, where the hawks hunted from a mixed mangrove-*Casuarina equisetifolia*-coastal scrub zone.

During our observations in the Los Indios mangrove habitat, *gundlachii* displayed passive still hunting from low ($\bar{x} = 1.3 \pm 0.94$; range = 0.2–3 m; $N = 54$) mangrove tree perches or from the ground. Prey captures were made in a low-angle flight, snatching the item (all observations of crabs) and continuing to a nearby perch, or the hawk landed near the crab and stalked it on foot. Once the hawk grasped the crab, it controlled the claws and legs on either side of the prey with its feet, then removed the carapace with a quick tug at the head region using its bill.

We found apparent caches of uneaten, though dismembered, land crabs near (range = 5–20 m) used *gundlachii* nests. However, we did not observe

hawks returning to the caches to feed on the stockpiled crabs.

Although *B. a. anthracinus* has been observed (O. Garrido pers. obs.) in Mexico hunting at the edge of a meadow in a fashion similar to that of the coursing behavior of the Northern Harrier (*Circus cyaneus*), *gundlachii* was not observed foraging aerially in an active manner.

Vocal behavior. The common call of *gundlachii* is a series of three or, uncommonly, four notes, with emphasis on the first two elements, suggesting its Cuban common name, *BA-TIS-ta* (Gundlach 1893, Garrido and Schwartz 1969, Garrido and Kirkconnell 2000; Fig. 2A). The call has a much shorter duration and fewer elements than in other populations of *Buteogallus anthracinus* (Table 5). The common call of mainland *anthracinus* consists of 9–24 notes, with the middle to the final third of the notes accentuated (Fig. 2C–F, Table 5). Stiles and Skutch (1989) characterized the call of mainland *anthracinus* as “*klee klee klee KLEE KLEE klee kle kle ke ki ki.*” The comparable call of *canrivorus* consists

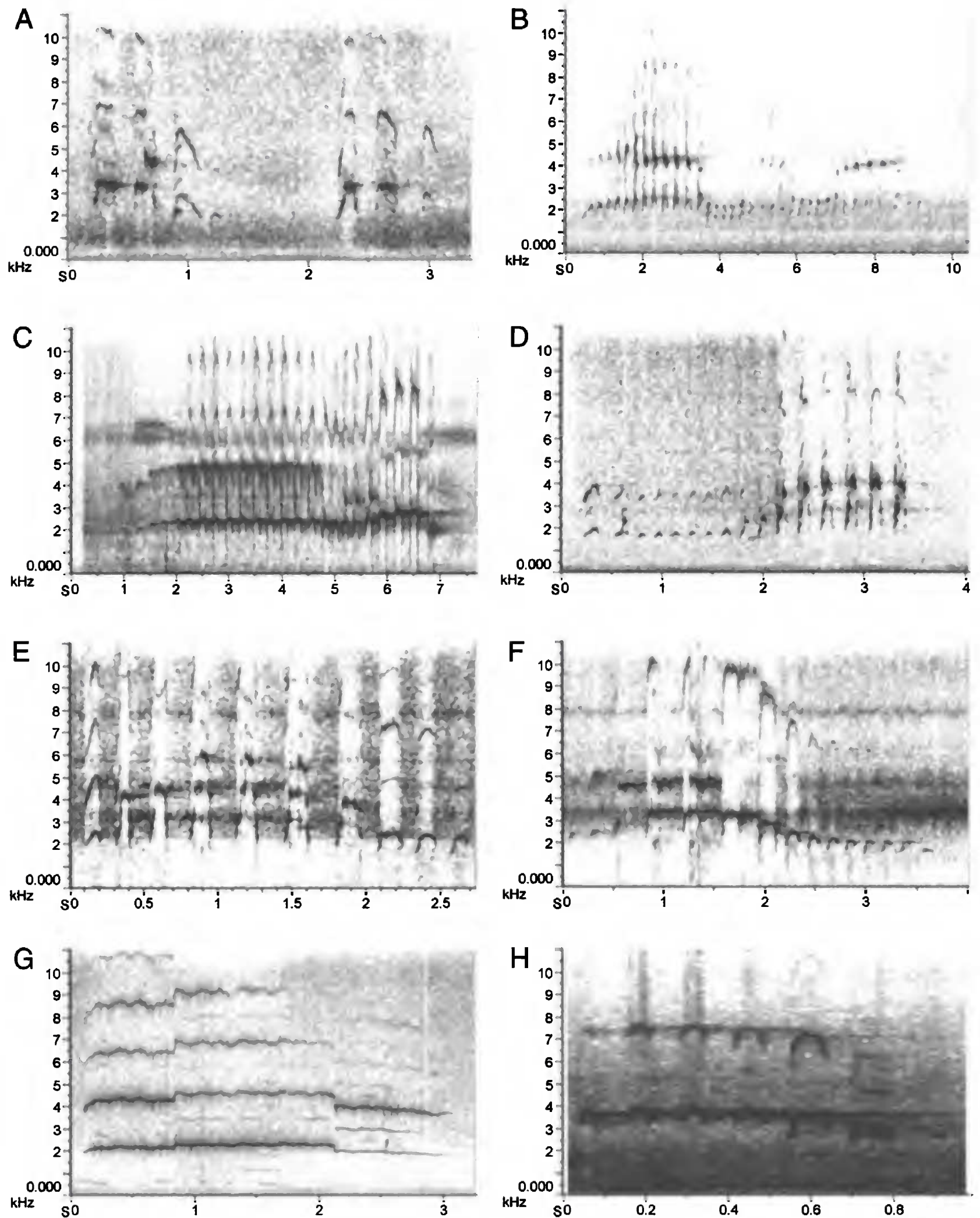


Figure 2. Sonographs of common (alarm) calls of *Buteogallus* species. A. *Buteogallus anthracinus gundlachii*, showing typical three element "ba-tis-ta" phrase, Cuba (G.B. Reynard). B. *Buteogallus a. cancrivorus*, St. Vincent (J. Roche, courtesy British Library Sound Archive). C. *Buteogallus a. anthracinus*, Costa Rica (Cornell Library of Natural Sounds 27216). D. *Buteogallus a. anthracinus*, Venezuela (P. Schwartz). E. *Buteogallus a. anthracinus*, male, Arizona (courtesy J. Schnell). F. *Buteogallus a. anthracinus*, female, Arizona (courtesy J. Schnell). G. *Buteogallus urubitinga*, Venezuela (P. Schwartz). H. *Buteogallus aequinoctialis*, Surinam (Paul Donahue, courtesy British Library Sound Archive).

Table 5. Characteristics ($\bar{x} \pm SD$, range in parentheses) of the common (advertisement) call of *Buteogallus anthracinus anthracinus*, *B. a. cancrivorus*, *B. a. gundlachii*, *B. urubitinga*, and *B. aequinoctialis*.

| FORM | N | DURATION(s) | NO. ELEMENTS | FREQUENCY (Hz) ^a | | | EMPHASIZED ELEMENTS |
|---------------------------------------|---|-----------------------|--------------------|-----------------------------|--------------------------|--|---------------------|
| | | | | LOW | HIGH | | |
| <i>B. a. gundlachii</i> | 7 | 0.9 ± 0.1 (0.8–1.1) | 3.1 ± 0.4 (3–4) | 1769 ± 96.6 (1632–1896) | 3751 ± 463.6 (3487–4786) | | 1–2 |
| <i>B. a. anthracinus</i> (Arizona) | 4 | 3.3 ± 0.7 (2.4–3.9) | 12.5 ± 3.0 (9–15) | 1317 ± 200.9 (1058–1524) | 3862 ± 333.1 (3647–4359) | | 5–7 |
| <i>B. a. anthracinus</i> (Costa Rica) | 5 | 4.5 ± 1.3 (2.7–6.3) | 16.2 ± 5.4 (11–24) | 1626 ± 198.9 (1359–1919) | 3054 ± 517.3 (2279–3725) | | 8–20 |
| <i>B. a. anthracinus</i> (Venezuela) | 2 | 2.6 ± 1.0 (1.9–3.3) | 12.5 ± 5.0 (9–16) | 1597 ± 20.0 (1583–1611) | 3632 ± 899.5 (2997–4269) | | 4–16 |
| <i>B. a. cancrivorus</i> | 8 | 7.3 ± 1.7 (5.0–9.5) | 29.5 ± 5.9 (22–37) | 1504 ± 99.3 (1340–1701) | 4555 ± 305.9 (4304–5087) | | 9–25 |
| <i>B. urubitinga</i> | 6 | 2.3 ± 1.6 (1.25–4.67) | 1.0 ± 0 (1) | 1734 ± 66.8 (1673–1862) | 3146 ± 270.2 (2794–3408) | | — |
| <i>B. aequinoctialis</i> | 5 | 1.0 ± 0.1 (0.9–1.0) | 7.6 ± 0.6 (7–8) | 2352 ± 126 (2199–2521) | 4140 ± 134.3 (4041–4348) | | 2–4 |

^a Fundamental tone.

of a large number of elements (22–37), with emphasis on several middle elements (Fig. 2B, Table 5). Similarly, the common call of *B. subtilis* is substantially different from that of *gundlachii*, consisting of several, rapidly repeated elements, described by Ferguson-Lees and Christie (2001) as a series of shrill whistles, indistinguishable from *anthracinus*. The call of *Buteogallus urubitinga* consists of a single note, drawn out in a high shrill “keeeeeeeeh” (Ferguson-Lees and Christie 2001; Fig. 2G), whereas that of *Buteo aequinoctialis* is a distinct series of whistle-like notes (Ferguson-Lees and Christie 2001; Fig. 2H, Table 5).

DISCUSSION

As is normal among most birds of prey, female *gundlachii* are somewhat larger than males, with culmen and wing length significantly different between genders. Sexual size dimorphism was less evident in *anthracinus* (\bar{x} Dimorphic Index = 4.0) than *gundlachii*, where we found a mean Dimorphic Index of 4.7 with males significantly larger than females in wing and culmen length (Table 1). Snyder and Wiley (1976) reported a lower index (2.7) of sexual size dimorphism for *B. anthracinus*.

Whereas measurements of selected body parts did not show complete distinction between *anthracinus* and *gundlachii* (Table 2, Fig. 1), Cuban birds were consistently smaller or at the small end of the range for *anthracinus* measurements. In contrast to our measurements, Bangs (1905) partly based his determination of separating *gundlachii* from *anthracinus* on the former being slightly larger than the latter, and in having a decidedly heavier, broader bill. As a general pattern, Schnell (1994) noted that Common Black-Hawks of continental (inland) North and Central America are largest. Mainland *anthracinus* populations inhabiting mangrove habitat tend to be smaller and browner than others. The race *B. subtilis rhizophorae*, which inhabits mangrove habitat (Monroe 1963, 1968, Blake 1977), shows a dark-brown plumage. Our observations revealed that Cuban birds, also mangrove inhabitants, are consistently browner with substantial differences in plumage pattern compared with mainland birds. Thus, such color differences may be a result of ecological parallelism, rather than of phylogenetic relationships.

The species of *Buteogallus* are partial to wetlands, swampy woods, and seacoasts (Amadon 1982). In its mainland range, *anthracinus* has been characterized as inhabiting woodlands around coastal

swamps, ponds, and streams, and especially mangroves in the swampy woodlands adjacent to the poorly-drained inlands that are affected by tide-waters (Phillips et al. 1964, Wetmore 1965, Davis 1972, Schnell 1994). Wetmore (1965) noted that along large rivers they extend their range farther inland. Thomas (1908) reported *anthracinus* in stretches of sand dunes and savannas with clumps of palmettos and pines. The Cuban population shows a similar preference for lowland coastal areas. Gundlach (1893) and Bangs (1905) noted *gundlachii* was found only in mangrove swamps and on the banks of large rivers. In broad contrast, the other West Indian population, *Buteogallus anthracinus cancrivorus* of St. Vincent, mainly keeps to the high wooded valleys, although it seldom occurs far from water (Lister 1880, Clark 1905b, Bond 1956a).

Cuban populations of the black-hawk breed from January through June (Garrido and Kirkconnell 2000), with egg-laying occurring in late March or April. Bangs (1905) collected a female containing a soft-shelled egg and found another tending a nest on 15 April. Bond (1950) reported a nest with a newly-hatched chick on 4 April. Garrido and Schwartz (1969) and Valdés Miró (1984) commented *gundlachii* builds its nest at a considerable distance above the ground. Gundlach (1876) reported a nest at 8 "varas" (6.8 m), whereas Bond (1936) noted one at 6.2 m.

Nests of the Cuban form are typically rough structures of twigs, lined with green leaves and, sometimes, debris (Gundlach 1893, Bond 1936, Garrido and Schwartz 1969, Valdés Miró 1984). Bond (1936), describing nests found in St. Vincent (*B. a. cancrivorus*) and Cuba (*gundlachii*), noted, "The nest, a rough mat of sticks, is placed at various elevations in trees." All nests located by us at Los Indios in 1996–98 were in mangroves (*Avicennia*, *Rhizophora*). In contrast, Bond (1936) described black-hawk nests in St. Vincent as "placed on top of clumps of mistletoe and were rather small." As Bond (1936) suggested, nests of the Cuban species are somewhat larger than those of birds in St. Vincent. Schnell (1994) gave the dimensions of mainland *anthracinus* nests as ranging from 38 cm diameter \times 20 cm deep to 1.2 m diameter \times 0.67–1.2 m deep. Bangs (1905) and Bond (1936) also noted *gundlachii* re-used nests in more than one season, which we believe accounts, in part, for the larger nest size of Cuban birds.

Black-hawks at Los Indios were remarkably non-

aggressive toward humans at their nests and allowed us to approach much closer than other local raptor species tolerated, perhaps relying on their cryptic behavior to avoid detection at the nest. Others have also noted this tolerance in Cuban black-hawks (Todd 1916, Barbour 1923, Garrido and Schwartz 1969).

Schnell (1994) reviewed available egg specimens for *Buteogallus anthracinus*, summarizing mean measurements from Bent (1937) as 57.3×44.9 mm ($N = 60$ eggs) and examples in the Western Foundation of Vertebrate Zoology as 57.30×45.50 mm ($N = 12$ clutches, 19 eggs; range = 52.61–62.02 mm length, 42.69–47.35 mm breadth). Eggs of *anthracinus* we measured at the Delaware Museum of Natural History averaged 57.46 (53.1 – 63.2) \times 45.25 (41.7 – 49.1) mm ($N = 13$ clutches, 21 eggs). Interestingly, an egg reported from St. Vincent is at the high end for the species: 61×47 mm (Bond 1936) and exceeds the range for *gundlachii*. Eggs of *gundlachii* we measured at Los Indios averaged only slightly smaller than those of mainland *B. anthracinus* analyzed by Schnell (1994). Gundlach (1876) reported that Cuban eggs measured 58×45 mm, whereas Bangs (1905) reported 56×45.5 mm. Measurements presented by Valdés Miró (1984) are obviously in error; i.e., $\bar{x} = 56.0$ (range = 55.0 – 57.0) \times 24.6 (23.0 – 26.5) mm. The mean mass (61.0 ± 1.8 g) of eggs we measured at Los Indios was somewhat lighter compared with Schnell's estimated mean mass of 63.8 g for *anthracinus*.

Although we observed differences in egg coloration and pattern among *anthracinus*, *subtilis*, and *gundlachii*, these characters show considerable variation and do not appear to be a good character for determining relationships (L. Kiff pers. comm.).

Schnell (1994) noted that, in general, clutch size of *Buteogallus anthracinus* decreased from two eggs in the northern range to one in the southern range; several reported three-egg clutches were questionable. Clutch sizes at Los Indios fell within that range, averaging 1.57 eggs per clutch.

Buteogallus anthracinus feeds mainly on invertebrates and lower vertebrates, with occasional small birds or mammals in the diet (Schnell 1994). For mainland populations, Thomas (1908) reported *anthracinus* preying on burrowing land crabs, which form almost the sole diet of the hawks in British Honduras (Belize). The St. Vincent population (*B. a. cancrivorus*) reportedly feeds on cray-

fish and freshwater crabs (Lister 1880). In Cuba, Gundlach (1893) reported remains of crustaceans, as well as frogs, snakes, and fishes in the stomachs of black-hawks. Barbour (1943) reported land crabs as its prey in Cuba. Garrido and Kirkconnell (2000) reported its prey as mainly crabs and birds, whereas Ramsden (C. Ramsden, Museo de Historia Natural, Universidad de Oriente, Santiago de Cuba unpubl. data) noted the hawk fed on crabs and fishes.

The hunting behavior of *Buteogallus*, in general, has been characterized as sluggish. Schnell (*in* Palmer 1988, 1994) noted *B. anthracinus* normally hunts from a stationary perch, often near the ground, from branches up to 15 m high, on boulders, other low perches, and gravel beds along streams. For Cuban hawks, Barbour (1923) described crab predation similar to our observations: "The hawk pounces on the crab, gathers the legs and claws of each side in one of its feet, and reaching down removes the carapace by hooking the bill under its front edge." Kirkconnell and Garrido (1991) reported *gundlachii* drowning its avian prey (Common Moorhen [*Gallinula chloropus*]), which they suggested was unusual and perhaps related to the abundant rain that caused the raising of the water level in the swamp, rendering crabs difficult to find.

We observed Cuban Black-Hawks caching crab prey near their nest, a habit that has also been reported for *B. anthracinus* in mainland sites (Thomas 1908, Schnell 1991, 1994).

As noted by Schnell (1994), descriptions of the vocal behavior of *Buteogallus anthracinus* have been confusing and conflicting. Schnell (1994) characterized the common call (= alarm call) as of a complex, un-raptor-like quality. The common call of mainland *Buteogallus anthracinus* is distinct from the three-note call of *gundlachii*, consisting of 9–24 notes (Reynard and Garrido 1988, Schnell 1994) (Figs. 2A, 2C–F, Table 5). Similarly, the common call of *B. subtilis* is distinct from that of *gundlachii*, consisting of several, rapidly-repeated elements, described by Ferguson-Lees and Christie (2001) as a series of shrill whistles, indistinguishable from that of *anthracinus*. The call of *Buteogallus aequinoctialis* is a series of six or seven whistle-like notes, the first three rapid, followed by slower and descending elements (Fig. 2H; Ferguson-Lees and Christie 2001). Finally, *B. meridionalis* has a call consisting of a prolonged whistle, described as

"eeeeee-eh" or "kree-ee-ee-er" (Ferguson-Lees and Christie 2001).

CONCLUSIONS

We consider *Buteogallus anthracinus* (with its geographical races, *cancrivorus* and *anthracinus*), *B. urubitinga*, *B. aequinoctialis*, and *B. gundlachii* as separate species. This treatment of the Cuban population agrees with Wetmore (1965:234), who stated the other forms stand apart: "... from the bird of the island of Cuba which it appears appropriate to treat as a separate species, *Buteogallus gundlachii*." Thus, the Cuban Black-Hawk *Buteogallus gundlachii* Cabanis, 1854 (1855), becomes a species endemic to Cuba, distributed in the main island, where it is relatively uncommon and quite localized, Isla de Pinos, and many of the keys of the Cuban Archipelago.

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